Assessing The Limits of Synthetic Controls:

On the Estimation of Causal Effects in Time Series Data Structures

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Abstract

Potential framework: We argue that applications of Synthetic Controls (SC) are faced with a self-selection problem. That is, the method is primarily applied to non-complex data structures that are straightforward to forecast, given the availability of donors in the post-treatment period. Using Monte Carlo studies, we show that the high interpretability of SC comes at the costs of poor predictions and forecasts, which are especially pronounced if the data generating process contains a time series structure. To address this issue, we introduce the intricacy-statistics that informs the applied researcher whether or not the data at hand exceeds a level of time series structure that SC can handle. If the case, more flexible methodologies that combine the strengths of SC and conventional time series techniques promise more accurate predictions and forecasts. Hence we introduce the new VAR-SC estimator, that takes in account both the time series structure and the availability of donors. In order to implement these ideas, we introduce the R-package complex_synths that provides ready-to-use functions to compute the intricacy-statistics and, based on the magnitude of the statistics, the functionalities to estimate either the SC or the VAR-SC model. To probe the performance of our methodology outside the experimental setting, we apply it to existing application of SC and to a highly complex data structure: The inclusion of a stock in an index. Specifically, we find that the inclusion of the German multi-national eCommerce company Zalando in the German stock index (DAX) caused an excess capitalization of XXX milion euro.

Keywords: *Causality; Enjoy Machine Learning*

List of Acronyms

USA United States of America

SC Synthetic Control

GDP Gross Domestic Product

1. Introduction

The method of Synthetic Controls (SC) is cool.

2. Literature Review 2-3 pages

2.1. Synthetic Control

The Synthetic Control (SC) method was developed by Alberto Abadie and colleagues in a series of influential papers ([Abadie and Gardeazabal, 2003], [Abadie et al., 2007], [Abadie et al., 2015]). The method is designed to estimate the causal effect of a treatment in a setting with a single treatment unit and a number of potential control units. Pre- and post-treatment data are observed for the treatment and control units for the outcome of interest and for a set of covariates that explain the outcome.
In their canonical 2003 article, Abadie and Gardeazabal assess the causal economic effects of conflict, using terrorist conflicts in the Basque Country as a comparative case study. Combining aspects of the matching and difference-in-difference literature, the scholars invent the SC method, which pursues the target to estimate causal treatment effects in observational studies. In their specific application example, they find that per capita Gross Domestic Product (GDP) of the treatment unit (Basque Country) declined about 10% compared to the synthesized control unit. The key underlying assumption is
Some text United States of America (USA)

2.2. Overview

[Abadie, 2021] read.
[Athey and Imbens, 2016] read.

2.3. Application

[Born et al., 2019] read.
[Cho, 2020] read.
[Cunningham, 2021] read.
[Funke et al., 2020] read.

2.4. Methodological Background

[Hainmueller et al., 2011] read.
[Abadie and Imbens, 2006] not read.
[Abadie and Imbens, 2002] not read.
[Doudchenko and Imbens, 2016]
[Ferman, 2021] read.
[Frangakis and Rubin, 2002] not read.
[Rosenbaum and Rubin, 1983] not read
[Rubin, 1974] not read.

2.5. Extensions/ Developments

[Abadie and L'Hour, 2021] read.
[Amjad et al., 2018] read.
[Ben-Michael et al., 2021] read.

[Ben-Michael et al., 2021] not read.
[Kellogg et al., 2021] not read.
[Kuosmanen et al., 2021] not read.
[Muhlbach and Nielsen, 2019] read.

Developments
[Arkhangelsky et al., 2021] not read
[Athey et al., 2017] not read.
[Brodersen et al., 2015] read.
[von Brzeski et al., 2015] read.
[Hartford et al., 2017] read.

2.6. Testing

[Andrews, 2003] not read.
[Cattaneo et al., 2021] not read.
[Chernozhukov et al., 2019] not read.
[Chernozhukov et al., 2021] not read.
[Firpo and Possebom, 2018] not read.
[Hahn and Shi, 2017] read.

2.7. Time Series Econometrics

[Martin et al., 2012] read.
[Harvey and Thiele, 2020] read.
[Breitung and Knüppel, 2021] partially read.

3. Theory (10pt, bold)

4. Simulation Study (10pt, bold)

some text

5. Applications (if any)

6. Conclusion

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